UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF AGRICULTURAL AND INDUSTRIAL CHEMISTRY

Minutes of Fourth Conference on Nutritive Value of Soybean Oil Meal

at the

Northern Regional Research Laboratory
Peoria, Illinois

March 19, 1951

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ATTENDANCE LIST

Alderks, O. H., Technical Division, The Buckeye Cotton Oil Company, Ivorydale, Cincinnati, Ohio

Beeson, W. M., Professor of Animal Husbandry, Purdue University, Lafayette, Indiana

Black, H. C., Assistant Director of Research, Swift and Company, Chicago, Illinois

Borchers, R., Department of Agricultural Chemistry, University of Nebraska, Lincoln, Nebraska

Calvert, F. E., Research Director, The Drackett Company, Cincinnati, Ohio

Freyer, Egbert, Charge of Technical Control, Spencer Kellogg and Sons, Inc., Buffalo, New York

Fritz, James C., Director, Nutritional Research Laboratory, The Borden Company, Elgin, Illinois

Goss, W. H., Associate Director, Department of Scientific Research and Technical Development, Pillsbury Mills, Inc., Minneapolis, Minnesota

Gray, R. E., Swift and Company, Chicago, Illinois

Hamilton, T. S., Professor of Animal Nutrition, Department of Animal Science, University of Illinois, Urbana, Illinois

Hayward, J. W., Director, Nutritional Research Department, Archer-Daniels-Midland Company, Minneapolis, Minnesota

Harris, G. W., The Borden Company, Elgin, Illinois

Houghtlin, R. G., President, National Soybean Processors Association, Chicago, Illinois

King, T. A., Illinois Farm Supply Company, Chicago, Illinois

Krider, J. L., Director, Research and Education, Central Soya Company, Inc., Decatur, Indiana

Liu, Tien, Research Chemist, The Drackett Company, Cincinnati, Ohio

McGinnis, James, Professor, Department of Poultry Husbandry, The State College of Washington, Pullman, Washington

Miller, J. E., Production Supervisor, Spencer-Kellogg and Sons, Inc., Decatur, Illinois

Nelson, J. Wesley, Research Director, Nutrena Mills, Inc., Minneapolis, Minnesota

Nesheim, Robert, Department of Animal Science, University of Illinois, Urbana, Illinois

Parkin, F. P., Superintendent of Solvent Extraction, Borden's Soy Processing Company, Division of The Borden Company, Waterloo, Iowa

Scott, H. M., Professor, Department of Animal Science, University of Illinois, Urbana, Illinois

Sherman, W. C., Manager, Biological Research Laboratories, Ralston Purina Company, St. Louis, Missouri

Sommer, W. A., Production Manager, The Borden Company, Elgin, Illinois

Takashima, Tony, Chief Chemist, The Borden Company, Elgin, Illinois

Terrill, S. W., Assistant Professor, Department of Animal Science, University of Illinois, Urbana, Illinois

Turner, Willard, A. E. Staley Manufacturing Company Decatur, Illinois

Wike, K. L., Research Assistant, Allied Mills, Inc., Libertyville, Illinois

Wilcke, H. L., Assistant Director, Research Department, Ralston Purina Company, St. Louis, Missouri

Witz, W. M., Archer-Daniels-Midland Company, Minneapolis, Minnesota

Wright, Kenneth, A. E. Staley Manufacturing Company, Decatur, Illinois

U. S. Department of Agriculture

Bird, H. R., In Charge, Poultry Investigations, Bureau of Animal Industry, USDA, Beltsville, Maryland

Northern Regional Research Laboratory

Babcock, Glen E., Chemist, Protein Properties, Isolation and Food Use Section, Oil and Protein Division

Beal, R. E., Chemical Engineer, Oilseed Section, Engineering and Development Division

Belter, P. A., Chemist, Protein Properties, Isolation, and Food Use Section, Oil and Protein Division

Benedict, R. G., Bacteriologist, Survey and Development Section, Fermentation Division

Brekke, O. L., In Charge, Oilseed Section, Engineering and Development Division

Cowan, J. C., Head, Oil and Protein Division

Curtis, J. J., Agricultural Technologist, Sample Culture Section, Analytical and Physical Chemical Division

Earle, F. R., In Charge, Analytical Section, Analytical and Physical Chemical Division

Gundrum, Laetta, Assistant Editor

Hall, H. H., In Charge, Feeds and Vitamins Section, Fermentation Division

Jackson, R. W., Head, Fermentation Division

Lancaster, E. B., Chemical Engineer, Oilseed Section, Engineering and Development Division

Langford, C. T., Head, Engineering and Development Division

Lathrop, E. C., Head, Agricultural Residues Division

Majors, K. R., Technical Assistant to Director

McKinney, L. L., In Charge, Industrial Protein Section, Oil and Protein Division

Milner, R. T., Director

Mustakas, G. C., Chemical Engineer, Oilseed Section, Engineering and Development Division

Ofelt, C. W., Chemist, Protein Properties, Isolation, and Food Use Section, Oil and Protein Division

Reiber, R. G., Chemist, Industrial Protein Section, Oil and Protein Division

Roethe, H. E., Assistant Director

Schubert, E. N., Chemist, Protein Properties, Isolation, and Food Use Section, Oil and Protein Division

Senti, F. R., Head, Analytical and Physical Chemical Division

Smith, A. K., In Charge, Protein Properties, Isolation, and Food Use Section, Oil and Protein Division

Van Ermen, L., Chemical Engineer, Oilseed Section, Engineering and Development Division

Walther, G. F., Chemical Engineer, Oilseed Section, Engineering and Development Division

PROGRAM

Chairman: J. W. Hayward, Director, Nutritional Research Department, Archer-Daniels-Midland Company, Minneapolis, Minnesota

Morning Session 8:55 - 12:30

Subject: Analytical Methods for Detecting Differences in Processing, Water Dispersibility, Nitrogen, Urease, Thiamin, Antitrypsin, and Browning.

Leader: J. C. Cowan, Head, Oil and Protein Division, NRRL, A. K. Smith, H. H. Hall, F. R. Earle and R. Borchers

Subject: Report on Heat Treatment Studies at University of Illinois.

Leader: T. S. Hamilton, University of Illinois, Urbana

Subject: Report on Collaborative Nutritional Studies of Soybean Research Council of National Soybean Processors Association and Nutritional Council of American Feed Manufacturers Association

Leader: J. Wesley Nelson, Nutrena Mills, Inc., Minneapolis, Minnesota

Subject: Report on Use of Vitamin B_{12}, Antibiotics, Animal and Marine Protein Supplements for Soybean Oil Meal

Leader: H. R. Bird, Bureau of Animal Industry, Beltsville, Md.

Subject: A New Phase of the Growth Inhibitor Problem.

Leader: Raymond Borchers, University of Nebraska, Lincoln

Discussion Period. *Leader:* J. W. Hayward

Subject: Arrangements for Collaborative Studies of Analytical Methods on Soybean Oil Meal

Leader: J. C. Cowan

Intermission for Lunch 12:30 - 1:30

Subject: Arrangements for Collaborative Feeding Tests with Rats, Chicks, and Pigs.

Leader: J. Wesley Nelson

Adjournment 2:30 p.m.

MINUTES OF THE MEETING

Dr. R. T. Milner called the meeting to order at 9 a.m. and greeted the 60 persons in attendance. He called attention to the recently published book on "Soybeans and Soybean Products," edited by Klare Markley, and especially the chapter on the nutrition of soybeans written by Dr. Mitchell of the University of Illinois. Dr. Milner also called attention to the series of collaborative experiments and conferences going on in the Southern Region and at the Southern Regional Research Laboratory, covering cottonseed meal processing and nutrition similar to studies and conferences in the Northern Region and at the Northern Regional Research Laboratory on soybeans.

Dr. Milner asked for self introduction by each of the persons present, and presented Dr. J. W. Hayward as chairman of the meeting. Dr. Hayward introduced Dr. J. C. Cowan as leader of a panel on analytical methods for determining differences in processing as determined by water dispersibility of nitrogen, urease activity, thiamin and anti-trypsin disappearance, and browning. Dr. Cowan introduced Dr. A. K. Smith who gave a talk on the relationship between the water solubility of nitrogen with heat treatment and a report of the results he had obtained relating nitrogen dispersion of the various test samples to nutritional value. The data indicate a correlation of nutritional results with the analytical results for a given meal but satisfactory interpretation, from one meal to another, is impossible at the present state of our knowledge.

The Caskey-Knapp test indicates occurrence of minimum urease destruction or a "raw" condition, and the du Pont test indicates the meal has been processed beyond the optimum on a nutritional basis. There is no urease test presently available that can be used to indicate optimum processing. Dr. Cowan then introduced Dr. H. H. Hall who enumerated the types of methods available for thiamin determination and discussed the advantages and disadvantages of each type of procedure. He stated that the chemical procedure was chosen for work on the soybean oil meal samples. The thiamin content seems to correlate highly with severity of heat treatment and shows a severe drop in over-heated samples. Dr. Cowan commented on the work by McGinnis at Washington State College, and similar tests at the Northern Regional Research Laboratory on fluorescence as a measure of heat treatment. This factor is apparently correlated with degree of heat treatment but lack of agreement in experimental values obtained at the different laboratories indicates that further study on standardizing the method may be needed.

Dr. Hayward introduced Dr. T. S. Hamilton who gave a report which summarized the nutritional investigation on soybean meal carried out at the University of Illinois by Drs. T. S. Hamilton, H. M. Scott, S. W. Terrill, J. L. Krider, and others. This work was divided into two phases. The first was concerned with use in swine and poultry feeding. A corn-soy diet at 20 percent protein level gave poor results and required the addition of riboflavin. Addition of B_{12} to the diet seemed to reduce the choline requirement of pigs, solvent meal seemed to be superior to expeller meal, and the solvent meal was improved by the addition of APF supplement, especially in conjunction with choline addition.

In poultry feeding tests by Dr. Scott there was no difference between the types of meals. Each was improved by the use of aureomycin. There was a sharp improvement in feeding efficiency of the meals after heating for 10 minutes at 212° F., and there was little or no further change after any longer heating period including 180 minutes at that

temperature. When meals were given heat treatments under varied conditions and fed to rats in paired feeding tests, it was impossible to differentiate between the experimental meals and the reference meal.

Dr. Hayward pointed out that critical temperatures (possibly 240°-250° F.) were not attained in any of the above-mentioned studies and that 240° F. is attained in many plants most of the time.

Dr. Scott stated there is no better known source of protein for poultry feeding than soybeans, except for a soy plus casein plus gelatine combination (15 parts casein, plus 10 parts expeller oil meal, plus 2 parts gelatine). With this combination and a 25 percent protein diet, four-pound birds were obtained on 2 1/4-pound feed in 12 weeks.

Dr. Hayward introduced Dr. J. Wesley Nelson who reported on collaborative nutritional studies of the Soybean Research Council of the National Soybean Processors Association and the Nutritional Council of the American Feed Manufacturers Association.

Dr. Nelson discussed the discrepancies in analytical results and their relation to heat treatment. There were wide variations in the determination of urease activity; however, the results for thiamin showed good agreement. Water dispersibility showed good agreement and decreased with increased heating; whereas there was poor agreement among collaborators in the determination of fluorescence, but an increase occurred with increased heat treatment. Results on the determination of antitrypsin factor were reported to Dr. Nelson in five different ways and were difficult to correlate. Likewise, biological values reported were obtained on chickens, on rats, on all male groups, and some on the basis of sex averages. Rations were divided into three categories: (1) "practical", (2) synthetic, and (3) vegetable rations. Actually, there were nine types of rations used. Any ration or method used showed the effect of raw meals. There was no correlation shown between a corn-soy ration and vitamin B_{12} or choline.

Dr. Nelson asked for information on use of Blaw-Knox equipment to get meals ranging from under to over-toasted and whether temperature or pressure could or should be varied.

Mr. J. E. Miller of Spencer-Kellogg indicated they could control their Blaw-Knox equipment closely enough to allow for either variable, temperature, or pressure and pressures could be varied and controlled up to 30 pounds.

Dr. Nelson reported on analyses of 159 different meals as follows:

Determination	*Range of results*	*Mean*
Water dispersibility	21.5 - 6.2	9.18
Urease	8.92 - 7.0	
Thiamin	2.11 - 0	0.83

Correlation coefficient between water dispersibility and thiamin was 0.507 ± 0.0397; between water-dispersibility and urease activity 0.54 ± 0.038; and between urease activity and thiamin content 0.412 ± 0.044.

All members of collaborating groups were thanked by Dr. Hayward for their efforts. Dr. Hayward introduced Dr. H. R. Bird who spoke on the value of supplements in ironing out

differences in the nutritional values of soybean meals due to processing. He stated that addition of B_{12} will improve any diet using soybean meal as the main source of protein. Animal and marine supplements may also supply factors other than B_{12}, and antibiotics seem to improve all diets for chickens. The B_{12} did not make up the difference between raw and treated meals. Amino acid supplements, specifically cystine and methionine, improve both raw and properly heated meals but do not make up the difference between the two meals.

Dr. Bird believes that tryptic inhibitor may have a more general effect on protein availability.

The effect of overheating could be overcome by use of added methionine and B_{12}.

The antibiotics do not seem to help *on controlled feed intake*; the antibiotic seems to allow for greater utilization of lesser amounts of feed. It seems to reduce the protein requirement of the chick *if growth rate is the criterion*.

There is a difference between responses of different commercial soybean meals with the addition of choline, although there is no difference in the choline content of the meals. There is also a difference between commercial meals in their response to added methionine.

Dr. Hayward introduced Dr. Raymond Borchers from the University of Nebraska. Dr. Borchers stated that trypsin inhibitor is of no value as a criterion of growth possibility. They have tried, unsuccessfully, to isolate or identify the antinutritional component from the meal. He has found in the dialyzable components of trypsin a small molecular weight, heat stable, component which appears to inactivate the antinutritional component of raw soybean meal.

Dr. Borcher's talk was followed by a general discussion period.

Mr. W. M. Witz made a correction in Table No. 12 of the Northern Regional Research Laboratory report.

Dr. Cowan asked Dr. James McGinnis for elaboration on the fluorescence test. Dr. McGinnis commented on factors such as grind. He said that he feels that the fluorescence test is good in checking nutritional value, *except on expeller meals*. On these they obtain high fluorescence values but still have good growth. Raw beans give values of 25 to 30, whereas expeller meals give values as high as 130.

Mr. Egbert Freyer of Spencer-Kellogg asked about heating soybean meal in an autoclave and then presented his chemical test data on meals prepared by Beacon Milling Company. These included light reflectance, modified urease, and Caskey-Knapp tests on meals with varied heat treatments. In addition, protein solubility data were obtained on these samples after grinding in different ways. Mr. Freyer concluded that the methods are satisfactory for indicating trends but are unsatisfactory for fine differentiation.

Dr. Hamilton brought out the point that agreement should be made on the use of terminology; i.e., biological value, ad lib feeding as compared with limited feeding, and possible confusion of variables and the improper significance ascribed to a variable when another might be responsible. Dr. Hayward questioned the type of diet as a criterion and Dr. Hamilton also pointed out that the critical factor may vary with

the point in the growth period. Mr. J. C. Fritz questioned correlation of laboratory extracted meals with commercial meals.

Dr. Cowan then discussed collaborative studies of analytical methods and raised three questions: (1) who would participate in the various studies, (2) did the membership wish that a committee be established for such studies, and (3) what methods should be studied. A questionnaire was presented to each person present to obtain their answers to the above questions. The meeting was adjourned for lunch at 12:30 p.m.

The afternoon session was opened by the introduction of Dr. McGinnis who discussed an evaluation study of 17 commercial soy meals. Fluorescence or brown color could not correlate with feeding tests, and there were large differences between meals in nutritional value. Three percent fish solubles helped to minimize the nutritional differences between the meals, but the addition of methionine plus lysine plus tryptophane did not help.

Dr. Nelson made arrangements for collaborative feeding tests with rats, chicks, and pigs.

It was agreed that use of antibiotics should be limited to Merck's B_{12} plus penicillin. The size of chick sample and sex of birds used were discussed but no definite agreement was reached. The protein level (synthetic ration vs. practical ration) was settled at a 16 percent level. Choline effect, and its possible interrelation with methionine, were discussed but no definite conclusions were reached.

It was agreed that synthetic ration would be used in conjunction with the practical rations of their own choice in the collaborator's tests.

Mr. W. M. Witz discussed the rat ration. A synthetic ration to standardize animals was agreed upon.

It was agreed that Dr. Nelson would be in charge of and handle all collaborative feeding work with chickens, rats, and pigs, and that Dr. Cowan should handle all collaborative work on analytical methods. The meeting was adjourned at 2:30 p.m.

Minutes prepared by Dr. C. W. Ofelt.
Complete report compiled by Dr. J. C. Cowan.

REPORT ON NITROGEN DISPERSION TEST AND UREASE

A. K. Smith, Oil and Protein Division
Northern Regional Research Laboratory

NITROGEN DISPERSION TEST

For several years, the soybean processors and nutritionists have been looking for a rapid routine laboratory test which would serve as a processing guide in the cooking or toasting of the meal to its maximum nutritional value. An ideal test should correlate with the more time-consuming animal assay test. Several tests have been proposed, including (1) the Caskey-Knapp and (2) the du Pont tests for the destruction of urease, (3) the disappearance of thiamin, (4) the destruction of the antitrypsin factor, (5) the color of the meal or an extract of the meal, (6) the fluorescence of a meal extract, and (7) the dispersibility of the meal nitrogen in water. Any of these tests will correlate to a certain extent with the improvement in nutritional value of the meal with steam treatment, but in the present state of their development none of them can be said to give a completely satisfactory answer to the problem.

So far as we know now, none of these tests measures the disappearance of the antinutritional factor occurring in the meal, and until this factor is identified we will have to continue with our empirical methods of testing.

The Northern Laboratory has had considerable interest in the dispersion of nitrogen in water as a measure of protein denaturation. The undenatured meal is selected by this test for industrial and food uses and in the present instance we are attempting to use it as a measure of optimum cooking of the meal during processing. A description of the test is included in the list of methods which has been handed you.

The change in nitrogen solubility of laboratory-prepared flakes, steamed in an autoclave at atmospheric pressure is shown in Figure 1. These data show a rapid loss in nitrogen for the first 15 minutes of treatment and a much slower change for the next 30 minutes. The minimum solubility values, as shown by similar curves from different sources, will vary for some unknown reason in the approximate range of 7 to 15 percent.

The solubility values for the test meals 1A, 2A, and 3A at about 25° C., which represent underheated, properly heated, and overheated meals are 88.7, 9.6, and 8.3, respectively. The values for the Pillsbury moisture samples PM1, PM2, and PM3, are 16.1, 17.2, and 16.9 percent. The Archer-Daniels-Midland moisture series, ADM1, ADM2, and ADM4 are 9.6, 8.4, and 5.9 percent, respectively.

Conclusion.

From our experience with the nitrogen solubility list it appears that for any given meal a satisfactory correlation can be worked out relating the nitrogen solubility with the nutritional data but there is not sufficient information available to make a generalization of these results for more than one processing plant or for meals from various unknown sources.

UREASE

The urease tests in their present form have well recognized limitations. The Caskey-Knapp method has worked out very well for detecting uncooked or raw soybean meal. A negative Caskey-Knapp test does not mean the urease has been entirely destroyed. In our experience, 15 minutes' steaming of flakes at atmospheric pressure destroys urease as determined by the Caskey-Knapp method. This method falls short of differentiating between optimum cooked or overcooked meals. Results in the present investigation as well as Hayward's recent publication in the July 29, 1950, issue of FEEDSTUFFS and others show that optimum steam treatment does not completely destroy the urease. This situation led to difficulties in the use of urea in soybean meal feeds and to the development of a new urease test, for detection of small residual quantities of urease by du Pont. Their test was designed to indicate when urease had been completely destroyed or reduced to a concentration that did not decompose the urea when mixed with soybean meal feeds. The best available information indicates that when soybean meal has been cooked to negative urease activity by the du Pont test, then it has passed its optimum nutritional value in the cooking cycle.

Conclusion:

From the available data we believe the Caskey-Knapp test is very reliable for detecting undercooked meal and the du Pont or similar test indicates when the meal has been overcooked, but we do not have a urease test which will show when the meal has been cooked to an optimum nutritional value.

REPORT ON THIAMIN

H. H. Hall, Fermentation Division
Northern Regional Research Laboratory

Methods for the assay of thiamin, its chemical properties which are of concern to this study and results of the assay of treated soybean oil meal were discussed.

Three basic assay procedures, their advantages and disadvantages are as follows:

1. *Rat assay.* Although very accurate, the method is costly, time consuming and few laboratories maintain rats.

2. *Microbiological.* This much used procedure depends upon thiamin stimulating alcohol production by yeast. Subject to errors introduced by non-thiamin stimulating substances and variation of assay organism.

3. *Chemical.* This method is rapid and reliable, permitting the complete assay of several samples per day. It is not subject to the usual unavoidable limitations of biological methods. The chemical method of Hennessy and Cerecedo, Ind. Eng. Chem., Anal. Ed., *13*, 216 (1941), used by NRRL was described in detail.

   Some properties of thiamin are: (1) water soluble, (2) heat stable when dry, (3) destroyed by moist heat, (4) possesses an oxidizable group in molecule, which is basis of chemical assay procedure.

The results of our assays for thiamin showed good correlation with method of treating samples of soybean oil meal. (See mimeographed reports.)

SOYBEAN RESEARCH AT THE UNIVERSITY OF ILLINOIS

T. S. Hamilton
Department of Animal Science

Introduction

For many years the Illinois Agricultural Experiment Station has been among the leaders responsible for the contributions to our present knowledge of soybeans. The Agronomy Department initiated research on soybeans in 1896 and since that time has made marked contributions in the development of new varieties and in the development of soybean production.

The animal production divisions particularly swine poultry and beef cattle, have long and continuous series of publications dealing with the uses of soybeans and soybean oil meal in feeds. Early work established the fact that "toasted" soybean oil meal was more palatable to animals and had a higher feeding value than did the unheated meal. The Swine Division has reported the results of many tests concerned with more efficient methods of formulating swine rations containing soybean oil meal. By 1948, the Swine Division had shown that, for growing and fattening weanling pigs in dry lot, a basal ration of corn and soybean meal had to be supplemented with minerals, the fat-soluble vitamins A and D, several of the water soluble B vitamins, and a source of the so-called "animal protein factor" which could be supplied by any number of protein concentrates of animal origin.

In 1937, Sybil Woodruff of the Home Economics Department (Proc. Amer. Soybean Assoc. vol. 17 (1937) 19) reported tests on the eating qualities of 467 varieties of edible soybeans and this department since then has conducted studies on the inclusion of soy flour in many bakery and other food products.

In 1928 the Division of Animal Nutrition published (Hamilton, Mitchell and Kammlade. Ill. Agr. Exp. Sta. Bul. No. 303) the first comprehensive study on the digestibility and metabolizable energy of various soybean products, using sheep as the experimental animal. Using the white rat, the division, in 1923, (Mitchell and Villegus. J. Dairy Sci. vol. 6 (1923) 222) demonstrated that autoclaving low-temperature-extracted ground soybeans improved the digestibility of the proteins 3-5 pct. but improved the utilization of the absorbed nitrogen 13-15 pct., suggesting that the heat treatment preferentially enhanced the digestive liberation of one or more of the amino acids limiting the use of soybean proteins by animals. Shortly after this, additional work in the division (cf. Mitchell and Smuts. J. Biol. Chem. vol. 95 (1932) 263) helped to confirm this suggestion by showing that cystine was the first limiting amino acid in soybean protein and that the deficiency was more severe in the unheated meal than in the heated meal. This was followed by a publication (Hamilton and Nakamura. J. Agr. Res. vol. 61 (1940) 207) reporting the cystine content of eleven varieties of soybeans.

Many other early tests and experiments on soybean meal have been made by the Illinois Station. These have indicated that the mixed proteins of soybeans are among the best, if not the best, balanced plant proteins and that they are equal to many of the better animal proteins for animal feeding; that there may be greater differences in the nutritive value of meals made by the same general method of removing the oil than usually exists in the average meals prepared by different methods; and that properly

prepared soybean meal may be used as the sole protein concentrate in farm rations when these are adequately supplemented with the missing vitamins. The details of these studies will not be given here and the remainder of my time will be devoted to some of the more recent findings by the Illinois Station.

Recent work on soybean meal

During the past few years, the Illinois Station, particularly the Swine Division, the Poultry Division, and the Animal Nutrition Division, has devoted a great deal of time in studying soybean meal from one or both of two angles. (1) How to use soybean meal most effectively in rations for swine and poultry. (2) The nutritive value of the proteins of soybean meal as affected by heat treatment. In this second study the samples have been furnished by the Northern Regional Research Laboratory of Peoria and by several manufacturers of soybean meal.

First I shall report briefly on some selected studies carried out by the Swine Division.

1. Dyer, Krider and Carroll (J. An. Sci. vol. 8 (1949) 541) carried out a series of four tests on the feeding of weanling pigs in dry-lot on a basal ration of corn and soybean meal. The soybean meal used was a blend of equal parts of 42 pct. expeller meals from Staley, Swift and Central Soya--Summary: "A 20 pct. crude protein ration largely of corn and soybean meal was nutritionally inadequate for weanling pigs in dry lot. The addition of either 1.5 mg. riboflavin, 6 mg. pantothenic acid or 250 mg. choline chloride per pound of ration significantly increased the average daily gains, while neither thiamine, niacin nor pyridoxine as additions to the basal ration had a significant effect on the rate of gain.

"When the basal ration included five B-vitamins (thiamine, riboflavin, niacin, pantothenic acid and pyridoxine), the addition of either 250 mg. choline chloride per pound of ration or 0.2 pct. dl-methionine or a combination of both very significantly increased the growth rates. The choline-methionine combination produced results which did not differ significantly from those obtained when either choline or methionine was fed. This indicates that the basal ration satisfied the indispensable choline and methionine requirements of the pigs but did not provide enough additional methyl groups for optimum growth."

2. In a later experiment, Dyer and Krider (J. An. Sci. vol. 9 (1950) 176) found that similar rations, to which a source of B_{12} had been added, were not improved by the addition of choline or methionine. In view of these findings, the authors suggested that B_{12} might have a sparing effect on the choline needs of an animal. Dyer and Krider reported also on results of feeding (a) expeller meals (blended from three sources), (b) a solvent meal (heated for 60 minutes at a maximum temperature of 230° F.) and (c) a special solvent meal (heated for 30 minutes in presence of steam at atmospheric pressure). The authors reported no differences in the growth-promoting properties of the two solvent meals but that either solvent meal was superior to the expeller meal.

3. Krider and Terrill, (J. An. Sci. vol. 9 (1950) 289) also reported that solvent soybean oil meal was more palatable and was consumed in larger quantities than was expeller meal when each was self-fed free-choice to pigs on pasture and receiving shelled corn and minerals.

4. Dyer, Terrill, and Krider (J. An. Sci. vol. 9 (1950) 281) reported another series of tests on pigs fed in dry lot and among these tests are some throwing light on the comparative nutritive values of expeller and solvent meals. The following statements were taken from their summary: "The basal ration including expeller soybean oil meal and 7 vitamins of the B complex was improved although not significantly so by either 4 pct. dried whey product with whey fermentation solubles, 5 pct. meat scraps or 0.05 pct. Merck's APF supplement, while the addition of 1.1 pct. Lederle's APF supplement significantly improved the rate of gain. When the basal ration contained solvent soybean oil meal, growth rate was not improved by the addition of either choline chloride or Merck's APF supplement. The latter supplement and all other sources of APF very significantly increased growth rate when choline chloride was also added to the ration. Pigs fed Lederle's APF supplement gained significantly faster than pigs fed an equivalent amount of vitamin B_{12} activity from another APF supplement..."

5. At the 1950 meeting of the American Society of Animal Production, Terrill and Krider (AS mimeo. 192) again reported on methods of improving a corn-soybean meal ration for feeding weanling pigs in dry lot. In the tests reported, comparisons were made of regular, special and high-protein (hulless) soybean oil meals with and without the additions of certain whey products and of aureomycin. From weanling to 75 lbs. in weight, no differences in the three unsupplemented soybean meals were found. Rations containing either kind of soybean meal plus dried whey product with whey fermentation solubles were markedly improved by the addition of 25 mg. aureomycin HCl per lb. of ration.

Now I would like to report one rather comprehensive series of results by Glista and Scott of the Poultry Division. These data were furnished by Dr. Scott and appeared in mimeograph form for the Illinois All-Industry Poultry Day, Urbana, Illinois, August 28, 1950. The data given by Glista and Scott follows:

SUMMARY OF STUDIES ON THE EFFECT OF HEAT TREATMENT ON THE GROWTH-PROMOTING QUALITIES OF SOYBEAN OIL MEAL

W. A. Glista and H. M. Scott

Table 1. Composition of Test Ration

	lb. per 100 lb.
Ground yellow corn	67.3
Soybean oil meal[1/]	27.0
Butyl fermentation solubles (500 µg./gm.)	1.0
Bonemeal	1.5
Limestone	1.5
Salt	0.5
A and D feeding oil (800D-2000A)	0.15
Manganese sulfate (feeding grade)	0.05
APF concentrate	1.00
Vitamin supplement[2/]	+
Total	100.00

1/ Samples varied in length of heat treatment. All contained approximately 53.7 pct. crude protein.

2/ Added per 100 lb. as follows: nicotinic acid 900 mg.; choline chloride 40 gm.; calcium pantothenate 200 mg.; crude folic acid (3.5 pct.) 506 mg. and menadione 45.4 mg.

Experiment 1

Table 2. Growth Data

Lot	Heat Treatment	Weeks 2	4	6	8	9
		(gm.)	(gm.)	(gm.)	(gm.)	(gm.)
1[1/]	None	128	[illegible]	616	961	1140
2	30 min. at 212	151	397	772	1159	1351
3	60 min. at 212° F	[illegible]	380	720	1103	1305
4	90 min. at 212° F	146	387	753	1143	1323
5	Positive control	147	392	748	1146	1336

1/ 20 x-bred males per lot

Table 3. Efficiency Data

Lot	Heat Treatment	Period 0-4 wk	0-8 wk	0-9 wk.
1	None	.464	.370	.357 (2.8)[1/]
2	30 min.	.529	.419	.400 (2.5)
3	60 min.	.542	.430	.414 (2.4)
4	90 min.	.547	.431	.411 (2.4)
5	Positive control	.571	.461	.441 (2.3)

1/ ( ) = lb. feed per lb. gain

Experiment 2

Table 1. Growth Data

Lot	Heat Treatment	Weeks 2	4	6	8
		(gm.)	(gm.)	(gm.)	(gm.)
1[1/]	None	116	287	531	853
2	10 min. at 212° F	138	359	663	1030
3	20 min. at 212° F	140	342	660	1000
4	30 min. at 212° F	148	382	699	1069
5	180 min. at 212° F	143	375	638	1023
6	Commercial	150	375	666	1011
7	None[2/]	123	318	596	927
8	30 min. at 212° F[2/]	147	380	708	1078

1/ 25 x-bred males per lot

2/ Plus 0.15 pct. DL-methionine

Table 2. Efficiency Data

Lot	Heat Treatment	Period	
		0-4 wk	0-8 wk
1	None	.423	.369 (2.7)[1/]
2	10 min.	.503	.422 (2.4)
3	20 min.	.470	.416 (2.4)
4	30 min.	.508	.420 (2.4)
5	180 min.	.500	.410 (2.4)
6	Commercial	.502	.413 (2.4)
7	None[2/]	.465	.399 (2.5)
8	30 min.[2/]	.513	.411 (2.4)

1/ ( ) = lb. feed per lb. gain

2/ Plus 0.15 pct. DL-methionine

It would appear from these data that (a) heat treatment improves the growth-promoting ability of soybean meal, and (b) there is no difference in the growth promoting abilities of meals heated from 10 to 180 minutes at 212° F.

Finally I would like to summarize the work done in the Nutrition Laboratory on the growth-promoting abilities and the biological values of the soybean meals prepared by the NRRL. The work has been done with the white rat and the methods were those adopted by the conference, August 8, 1948.

SUMMARY OF GROWTH AND BIOLOGICAL VALUE TESTS[1] (ILLINOIS)

Test No	SBOM samples compared	Growth: Gm. gain per gm. food protein	Growth: Difference	Growth: P[2] Value	Biological Values: Pct.	Biological Values: Difference	Biological Values: P[2] Value
1	Reference vs.	2.49	.02	0.4	75.2	1.00	0.4
	o press - 15 min.	2.47			74.2		
2	Reference vs.	2.41	.03	0.38	71.2	1.2	0.41
	o press - 45 min.	2.38			70.0		
3	Reference vs.	2.31	.12	0.21	69.3		
	o press - 75 min.	2.19			70.0	0.7	0.46
4	Reference vs.	2.46	.05	0.39	67.7	2.7	0.29
	o press - 105 min.	2.41			65.0		
5	Reference vs.	2.58	.38	.05	66.5		
	o press - 135 min.	2.20			67.8	1.3	0.4
6	Reference vs.	2.45	.19	.05	78.5	17.9	.001
	1 lb. psig. - 15 min.	2.26			60.6		
7	Reference vs.	2.26	.06	0.42	73.0	3.3	0.31
	5 lb. psig. - 15 min.	2.20			69.7		
8	Reference vs.	2.51	0.11	0.46	69.4		
	8 lb. psig. - 15 min.	2.40			70.3	0.9	0.39
9	Reference vs.	2.13			71.2	3.4	0.10
	11 lb. psig. - 15 min.	2.17	.04	.4	67.8		
10	Reference vs.	2.49			67.0		
	15 lb. psig. - 15 min.	2.54	.05	.38	67.5	0.5	0.4

1/ Each test is the average of 8 - 12 pairs rats.

2/ A P value of .03 or less may be considered significant.

It would seem, from these data, that, within the ranges of temperatures and lengths of time of heating, the quality of the proteins of soybean meals used in these studies is about the same and is not significantly different from that of the proteins of the Reference meal.

Conclusion

The conclusions that may be drawn from the work on soybean meal at Illinois are as follows:

1. On the average, the present-day solvent meals appear to be slightly superior in feeding value to the expeller meals. Palatability may be the chief reason for this.

2. Soybean meal may be improved in nutritive value by the addition of 0.2 to 0.3 pct. of methionine.

3. The nutritive value of soybean meal is improved by heating; suitable conditions under which the heat is applied seem to cover a rather wide range of temperatures and lengths of time.

4. No significant differences in the nutritive quality of the proteins of solvent soybean meal exist when the meal, at 14 pct. moisture, is heated at atmospheric pressure and approximately 218° F for periods of time varying from 15 to 135 minutes or when heated for 15 minutes at pressures varying from 1 to 15 lbs. per square inch gauge.

REPORT ON COLLABORATIVE NUTRITIONAL STUDIES

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The analytical methods for Water-Soluble N and Thiamine were essentially as described by NRRL. The Cargill Urease Activity Test is described in the accompanying report. It has been found to be useful in regular protein control labs that don't have a potentiometer to measure the increase in pH by the regular Caskey-Knapp method.

One hundred and fifty-nine commercial samples of soybean oil meal representing varying processing conditions of both expeller and solvent meals were tested. The values for Water-Soluble N varied from 6.2 to 21.5, with a mean of 9.18. The values for Urease varied from .9 to 9.5, with a mean of 2.65. The values for Thiamine varied from 0 to 2.11, with a mean of .83.

The correlation coefficients were as follows:

r Water-Soluble N and Urease	.54 ± P.E. .038	r^2 = 29%
r Water-Soluble N and Thiamine	.51 ± P.E. .040	r^2 = 25%
r Urease and Thiamine	.41 ± P.E. .044	r^2 = 17%

Thus from this series of tests we can say that in from 17% to 29% of the time one test will show perfect correlation with another. This is not perfect correlation but is probably as close as any tests that have been devised for measuring the quality of soybean oil meal.

Discussions and Conclusions

Correction-There are a few errors in the tables as follows: The urease value for collaborator 3(1) and under 1A should be 1.96 instead of 1.69. The relative chick growth for collaborator 2(2) and under 3A should be 88.68 instead of 77.05, and the values for 18(1) are for males; the values for the females being 75.18, 100 and 93.62, and the sex average 70.34, 100 and 88.13. The average for all collaborators under 3A should be 95.39 instead of 91.

These collaborative studies in general indicate good agreement between labs. At least the biological values agree as good as the chemical tests. But it does indicate we probably need to get together on the methods used. By biological values we mean the results of growth feeding studies.

No effort was made to standardize the methods as it was hoped something could be learned from the different procedures being used in the various labs.

Urease, thiamine and water dispersible protein (water-soluble N) seem to be used the most to determine the nutritive quality of soybean oil meal. The idea is to get as much of the urease or anti-trypsin factor destroyed as possible without destroying any

* These tests and calculations were performed by Janet Barr and Alice Perrin.

more of the water soluble N and thiamine than can be helped. Actually, these factors are probably not what we want to destroy but until we know what it is we have to accept these tests. It is apparent that some urease activity can be left in and still get maximum nutritive value.

The values for relative chick growth were calculated from the figures submitted by taking the values for the 2A meal as 100% and figuring the other values in terms of that. It is obvious that the raw meal has very low feeding value regardless of the ration or whether chicks or rats were used. The overheated meal gave poorer growth when synthetic rations were used in which the soybean oil meal furnished all the protein for either chicks or rats. However, when other ingredients furnished some protein, it was not so easy to demonstrate this effect. There was not enough similarity in rations to determine whether corn alone or with alfalfa, mill feeds or other grains or practical rations would be the best test ration to use.

The same conclusions could be drawn for the effect on feed efficiency, namely, that the raw meal resulted in poor feed efficiency but there was no significant difference in the feed efficiencies on the other two meals.

This study was sufficiently enlightening to encourage further studies.

We are indebted to the 21 collaborators who took part and hope they will take part in further collaborative studies. If you cannot identify your results from the way they are reported, please drop me a line and we will send you your number.

USE OF VITAMIN B_{12}, ANTIBIOTICS, ANIMAL AND MARINE PROTEIN SUPPLEMENTS FOR SOYBEAN OIL MEAL

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Bureau of Animal Industry

Any diet for growing chickens which is composed largely of grains and soybean oil meal, without animal protein supplement, is deficient in vitamin B_{12} unless a special B_{12} supplement is provided. Animal and marine protein supplements improve such a diet by supplying not only vitamin B_{12} but also one or more unknown factors. The growth stimulating effect of antibiotics is not related to the soybean oil meal content of the diet. An antibiotic supplement stimulates growth whether the diet contains soybean oil meal or not.

A diet composed largely of grains and properly heated soybean oil meal supports better growth of chickens than does a similar diet containing under-heated or over-heated meal. Diets containing under-heated or properly heated meals are improved by B_{12}[1] or methionine[2], but the difference between the meals is not compensated by these supplements.

An experiment in which growing chicks were fed soybean oil meal as the only source of protein in a diet composed otherwise of purified ingredients showed that lysine, methionine, and a complex vitamin mixture almost completely eliminated the difference between over-heated and properly heated meals[3]. Another experiment in which growing rats were fed soybean oil meal as the only source of protein in a diet composed otherwise of purified ingredients showed that methionine and vitamin B_{12} eliminated the difference between over-heated and properly heated meals.[4]

Some commercial soybean oil meals are supplemented more effectively than others by methionine[5] and by choline[6] when fed to chicks with corn and mineral and vitamin supplements. This might indicate an effect of the methionine or choline in overcoming differences in processing.

1/ Rubin and Bird, J. Nutr. 34 233 (1947)

2/ Hayward and Hafner, Poultry Sci. 20:139 (1941)

3/ Clandinin et al., Poultry Sci. 26:150 (1947)

4/ Witz and Hayward, unpublished data (1951)

5/ "Methionine, an important essential amino acid," Dow Chemical Co., Midland, Michigan (1951)

6/ Marvel et al. Poultry Sci. 24:46 (1945)

ANTI-SOYBEAN-GROWTH-INHIBITOR

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One phase of our work on the soybean growth inhibitor has been designed to answer this question: Is there a dietary supplement which will counteract the soybean growth inhibitor? Feeding of an extensive list of materials (commonly accepted sources of unidentified as well as recognized dietary factors) failed to influence the growth difference between heated and raw soybean oil meal. When crude trypsin powder was included in the heated and raw soybean rations, growth was similar. Stability and fractionation of the crude trypsin has established that the factor is not trypsin itself. Our work thus far gives a positive answer to our objective, that is, there is a dietary supplement which will counteract the soybean growth inhibitor. We have given the tentative name of "anti-SGI" to this factor.

REPORT ON STUDIES AT STATE COLLEGE OF WASHINGTON

James McGinnis
Department of Poultry Husbandry

Objective:

1. To determine whether the feeding value of different commercial samples of expeller and solvent processed meals is correlated with brown color and fluorescence.

2. To determine the effect of supplementing each meal with amino acids and fish solubles on nutritional value.

Procedure:

Crossbred chicks (N.H. x L.W.) which were kept on a corn-soybean diet for one week were used in this experiment. They were rigidly culled to eliminate unhealthy and unthrifty chicks. Twelve chicks were used in each group, and each experimental diet was fed to two groups of chicks.

Basal diet was supplemented with 3 percent solubles and amino acids (methionine, lysine, and tryptophane).

Conclusions:

1. When the series of different soybean oil meals were fed without supplementing, some marked differences in nutritional value were evident. However, statistical analyses of the data indicated that these differences were probably due to change.

2. Supplementation of the different soybean oil meals with fish solubles gave an increase in growth of chicks and tended to reduce differences in nutritional values of the various meals.

3. Supplementation of the soybean oil meals with a combination of methionine, lysine, and tryptophane failed to improve nutritional value.

4. The variations in nutritional value of different soybean oil meals could not be correlated with fluorescence, brown color, or urease activity.

SUMMARY OF QUESTIONNAIRE

Approximately one-half of the people participating in the conference turned in a questionnaire, and most of the groups were represented. Thirteen questionnaires plus one note indicating a desire for limited participation were received. The following summarizes the information:

10 desired to participate in analytical determinations
11 desired to have a committee to study the correlation of analytical methods with nutritive value

	Helpful Analysis	*Will Run*
Moisture	7	7
Protein	8	8
Fat	5	5
Water-Soluble N	8	8
Urease		
Increase PH 30 min.	8	7
Modified (SK)	1	1
DuPont		1
Thiamin	10	7
Trypsin Inhibitor	3-5	2
Color	7	4
Fluorescence	6	3
Fiber as Lignin, Pentosan, Cellulose	1	
Fiber	4	5
Browning	3	3
Sieve Analysis	4	6

- - - - - -

Will conduct Feeding Studies:

Chicks	7
Rats	7
Pigs	1
Turkeys	1

FIGURE CAPTION

Fig. I. Change in Nitrogen Dispersibility of Soybean Meal in Water with Increasing Time of Atmospheric Steam Treatment. Curve I, the Flakes Steamed After Solvent Extraction of the Oil, and Curve 2, the Flakes Steamed before Solvent Extraction.